SOC	QUALITY PLAN SYSTEM LEVEL PROCEDURE ISO 9001:2008 SOC HAWTHORNE DIVISION	DOCUMENT NO. QP.EMS.HG0002
	TITLE PROCESS SAFETY INFORMATION- STANDARD PROCEDURE FOR THE MERCURY STORAGE AND TRANSFER PROGRAM TO COMPLY WITH NDEP - CAPP	REV. 8
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CONCURRED BY BOYNTON.JASON.D.1228903430 Digitally signed by BOYNTON.JASON.D.1228903430 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=DLA, cn=BOYNTON.JASON.D.1228903430 Date: 2014.09.16 09:43:26 -04'00'	MANAGER DLA STRATEGIC MATERIAL FACILITY	DATE 9/2014
CONCURRED BY HARDER.CHARLES.1229070270 Digitally signed by HARDER.CHARLES.1229070270 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=DLA, cn=HARDER.CHARLES.1229070270 Date: 2014.09.16 10:38:06 -04'00'	MANAGER DLA STRATEGIC MATERIAL PROJECT	DATE 9/2014
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APPROVED BY	REPRESENTATIVE HWAD GOVERNMENT STAFF	DATE 9/2014
[ ] INITIAL RELEASE		[ ] REVIEW, NO REVISION REQUIRED

REVISION HISTORY

THIS DOCUMENT WILL BE REVIEWED AT LEAST ANNUALLY TO ENSURE ITS SUITABILITY

REV	CHANGE DESCRIPTION	AUTHOR	DATE
8	Reformatted document to comply with the QMS standard 9001. Changed wording document throughout to state Mercury Storage and Transfer Program. Added DLA personnel responsibilities of the CAPP Training Program procedure. Added administrative changes to the signature block. All Tier 1 documents are available on the G-drive: **G:\Intranet\Environmental\ environmental_programs\air\CAPP from Intranet**	Robert Mathias, SOC FES/ Renee Little BOP's Secretary	09/2014
7	Added Approval Signatures to this document. Added the following to the Approval Signatures, "By reviewing and approving this procedure, the approver understands and will comply with the state procedure. Your signature is proof that training has been provided. The approver also understands that he/she may withhold their signature if he/she has questions about the content and may contact SOC Environmental Services to resolve questions." MOC #0051 Meeting held 05-25-11 Updated personnel titles. Commander would like HWAD Representative to sign documents	Yvonne Downs, SOC Env/ Rob Mathias, SOC FES/ Cheri Bryant, SOC Security/ Melissa Waggoner, SOC QA/ Jason Cardenas, SOC HR/ Nancy Rutherford, SOC HR/ Wayne Larson, SOC Safety/ Julie Moss, SOC Maintenance/ Mark Jackson, SOC Eng Svcs/ Leanne Cornell, SOC HR/ Suzy Berry, SOC QA/ Via email – Teresa McNally, SOC Traffic/ Herman Millsap, DLA / Tom Erickson, PMSG Dir	06/20/11
6	Name change from DZHC to SOC. Added Performance Mgmt Support Group Director to signature line and changed Base Operations to Installation Support Services in the signature line.	Yvonne Downs, Env Svcs	01/19/2011
5	Changed DLA/DNSC to DLA Strategic Materials; Corrected name of SOC.QP.QAD.0002 from "Inspection of Mercury Storage Sites" to "Mercury Storage Site & Stockpile Inspection"; changed the number of open doors to four open doors; added additional reference items	Yvonne Downs, Env Svcs/ Herman Millsap, DLA Sandra Carroll, Tetra Tech	09/27/10
4	Changed the Design of the Relief System and Basis for the Design from: "CO_2 fire suppression system contains an Anderson Greenwood, ¾ inch, 1-061-0355 Direct Acting Relief Valve set at 357 psi. The pressure vessel (CO_2 tank) maximum allowable working pressure is 357 psi at 200°F per the name plate. The CO_2 tank capacity is 12,000 lbs, and the maximum volume allowed through administrative control is 10,800 lbs. Pressure relief devices, settings, and capacities were tested by the system vendor at the time of its commission, and all systems were determined to be sufficient. The results of these tests were reviewed during the PHA and are included in the PHA report for the CO_2 system." Added new section called Management Plan and Document Control.	Yvonne Downs, Env Svcs/ Herman Millsap, DLA Rep/ Sandra Carroll, Tetra Tech/ ORNL Team/ CAPP Team, NDEP	07/15/10

REFERENCE DOCUMENTS	
DOCUMENT NUMBER	**DOCUMENT TITLE**

DOCUMENTS REFERENCED IN THIS PROCEDURE ARE APPLICABLE TO THE EXTENT SPECIFIED HEREIN.

1. PURPOSE

The Process Safety Information (PSI) Procedure forms the basis of the process hazard analysis for the Mercury Storage and Transfer Program including the carbon dioxide (CO_2) fire suppression systems in the 14 Hg storage warehouses.

2. ACRONYMS

- **ACGIH** – American Conference of Governmental Industrial Hygienists
- **ASME** – American Society of Mechanical Engineers
- **CAPP** – Chemical Accident Prevention Program
- **CFR** – Code of Federal Regulations
- **CM** – centimeter
- **CO_2** – Carbon Dioxide
- **DLA** – Defense Logistics Agency Strategic Materials
- **FES** – Fire & Emergency Services
- **ft** – foot
- **ft^2** – square foot
- **ft^3** – cubic foot
- **GOC** – Guard Operations Center
- **Hg** – Mercury
- **HWAD** – Hawthorne Army Depot
- **IR** – Infrared
- **ISO** – International Organization for Standardization
- **L** – Liter
- **lb_f/in^2** – pounds force per square inch
- **MSDS** – Material Safety Data Sheet
- **NAC** – Nevada Administrative Code
- **NDEP** – Nevada Division of Environmental Protection
- **NFPA** – National Fire Protection Association
- **MM** – millimeter
- **NRS** – Nevada Revised Statutes
- **ORNL** – Oak Ridge National Laboratory
- **OSHA** – Occupational Safety and Health Administration

- **P&ID** – Piping and Instrumentation Diagram
- **PEL** – Permissible Exposure Limits
- **PHA** – Process Hazard Analysis
- **PSI** – Process Safety Information
- **psi** – pounds per square inch
- **psig** – pounds per square inch gauge
- **SOC** – SOC Nevada LLC
- **SOP** – Standard Operating Procedure
- **SP** – Standard Procedure
- **STEL** – Short Term Exposure Limit
- **TLV** – Threshold Limit Value
- **TWA** - Time Weighted Average
- **UN** – United Nations
- **°F** – Degrees in Fahrenheit
- **°C** – Degrees in Celsius
- **ng/m^3** – nanograms per cubic meter
- **MMTS** –Mobile Mercury Transfer System

3. REGULATORY REQUIREMENTS

This procedure is required by the Nevada Division of Environmental Protection (NDEP) Chemical Accident Prevention Program (CAPP) under Nevada Administrative Code (NAC) 459.95412. Specifically, SOC Nevada LLC (SOC) must comply with:

NAC 459.95412 Compilation of information concerning process safety. (NRS 459.3818, 459.3833)

1. The owner or operator of a facility with a process that is subject to CAPP shall compile written information concerning process safety before conducting a process hazard analysis required pursuant to NAC 459.95414.

2. The information concerning process safety must include, without limitation, information pertaining to:
   a. The hazards of the highly hazardous substances or explosives, including, without limitation:
      i. Toxicity information;
      ii. Permissible exposure limits;
      iii. Physical data;
      iv. Reactivity data;
      v. Corrosivity data;
      vi. Thermal and chemical stability data; and
      vii. The foreseeable hazardous effects of inadvertent mixing of different materials. Material safety data sheets that satisfy the requirements of 29 CFR § 1910.1200(g) may be used to comply with this requirement to the extent they contain the information required by this paragraph.
   b. The technology of the process, including, without limitation:
      i. A block flow diagram or simplified process flow diagram;
      ii. The process chemistry;
      iii. The maximum intended inventory;
      iv. The safe upper and lower limits for any applicable process variable, including, without limitation, temperature, pressure, flow and composition; and

v. An evaluation of the consequences of deviations.

c. The equipment in the process, including, without limitation:
   i. The materials of construction;
   ii. Piping and instrument diagrams;
   iii. Electrical classification;
   iv. The design of the relief system and the basis for the design;
   v. The design of the ventilation system;
   vi. Design codes and standards that were employed;
   vii. The material and energy balances for processes that were built after May 26, 1992; and
   viii. The safety systems, such as interlocks, detection or suppression systems.

3. The owner or operator shall evaluate processes and equipment for conformance to applicable codes, standards and good engineering practices and document that the processes and equipment comply with recognized and generally accepted good engineering practices.

4. For existing processes and equipment designed and constructed in accordance with codes, standards or practices that are no longer in general use, the owner or operator shall determine and document that the equipment is designed, maintained, inspected, tested and operating in a safe manner.

4. RESPONSIBILITIES

SOC Environmental Services Manager & DLA Strategic Materials Project Manager
Has overall responsibility for the administration and requirements of the PSI Program.

SOC Fire & Emergency Services (FES) Chief
Has responsibility for management of the Hg monitoring and response program elements that include the testing, inspection, and maintenance of the low pressure CO_2 fire suppression systems in the Hg storage warehouses, Hg monitoring instruments and calibration, and safe work practices for FES personnel.

SOC Equipment Maintenance, Electric Shop Manager
Has responsibility for the refrigeration components of the CO_2 systems, ensuring that a maintenance program is in place, and that process safety is performed in accordance with internal procedures.

SOC Engineering, Facilities, and Planning Manager
Has responsibility for providing engineering technical support to the Fire Chief and Equipment Manager.

SOC Safety & DLA Strategic Materials Safety Manager
Has responsibility for providing health and safety technical support to the Fire Chief and Environmental Services Manager.

SOC Maintenance and Utilities Manager
Has responsibility for providing technical support to the Fire Chief and Environmental Services Manager.

Hawthorne Army Depot (HWAD) ACO Environmental Management Services
Has responsibility for providing technical support to the SOC and DLA Strategic Materials staff.

5. PROCESS SAFETY INFORMATION PROCEDURE AND DOCUMENT CONTROL

SOC Environmental Services Manager and DLA Strategic Materials Project Manager are responsible for the technical development, implementation and integration of this procedure. The DLA Strategic Materials Facility Manager, SOC Safety Office and FES Chief will assist the SOC Environmental Services Manager in the development and collection of information required by this procedure. The following organizations will participate in the implementation and integration of this procedure and its contents and ensure their respective procedures address and mitigate the safety and health issues compiled in the PSI:

- DLA Strategic Materials
- SOC Environmental Services
- SOC Safety
- SOC Fire & Emergency Services
- SOC Equipment Management
- SOC Engineering Services
- SOC Facilities & Utilities
- SOC Quality Assurance

This procedure and its contents will be reviewed at least annually and whenever a process change (refer to Management of Change Procedure) is proposed. The review will be documented in the signature area located near the end of this document. Changes to the PSI, other than administrative changes, may trigger review and/or update of the Process Hazard Analysis (PHA) documentation, both the procedure and past PHA reports.

This document follows the International Organization for Standardization (ISO) 14001 Control of Documents Standard Procedure and the Standard Operating Procedure Program.

The PSI developed for the MMTS (2014-MSSP- 41, Rev. 1, Process Safety Information for the Mobile Mercury Transfer System to Comply with the NDEP) is an addendum to this PSI procedure.

The PSI will include the following information:

- Material Safety Data Sheets (MSDS) and/or other substance hazard information that applies to the CAPP-regulated process
- Block flow diagrams [included in the PHA for Mercury Receipt and Storage (April 2007) and the Supplemental PHA (for the CO_2 fire suppression system, June 2009)]
- Process chemistry if/when applicable (not applicable for Mercury Storage and Transfer Program)
- Maximum on-site inventory of hazardous materials
- Safe limits for process variables (pressure, temperature, flow, stream composition, equipment tolerances/limits, as applicable; to Mercury Transfer Program, only pressure and temperature apply to the Mercury Storage Program)
- Evaluation of the consequences of deviations from safe limits
- Comprehensive equipment and piping design
- Evaluation of chemical compatibility between the hazardous material and equipment/piping composition
- Evaluation of process design parameters
- Information on instruments, instrument design and compatibility to support the process

- Information on and evaluation of piping and instrumentation diagrams (P&IDs) that cover the entire regulated process, including auxiliary systems and utilities and control logic
- Identification of electrically hazardous areas and evaluation of electrical equipment compatibility, when applicable
- Identification of and evaluation of the adequacy of pressure relief devices, headers, flares or scrubbers, associated with the process (headers, flares and scrubbers are not applicable to the Mercury Storage and Transfer Program)
- Evaluation of and adequacy of ventilation systems for processes enclosed in the Mercury Storage buildings and the MMTS.
- Heat and material balances when applicable (not applicable to Mercury Storage and Transfer Program)
- A Safety System Description that addresses emergency shut-downs; infrared, heat and smoke detectors; fire suppression systems; emergency generator or uninterruptible power supplies (back-up power); ventilation systems; system alarms; other safety systems (key switches, door contact switches, motion detectors, etc.)
- Evaluation of the applicable codes, specifications, and/or best engineering practices; evaluation of the facility compliance; any corrective actions taken to correct deficiencies with applicable codes, specifications, and/or best engineering practices for Mercury Storage and Transfer buildings (not applicable to container storage of mercury; applicable to CO_2 fire suppression system)

6. PROCEDURE IMPLEMENTATION

1. This procedure and the information collected to meet the procedure requirements (see Process Safety Information - Mercury Storage and Transfer Program and supporting documents) are available to affected HWAD and DLA Strategic Materials personnel via the SOC Nevada G-drive (G:\Intranet\Environmental\environmental_programs\air\CAPP from Intranet).
2. Internal audits are conducted under the CAPP Compliance Audit Program and the ISO 14001 Internal Audit Standard Procedure (SP) to assure compliance at a minimum of every three years. The DLA Strategic Materials or their subcontractor also will audit the Mercury Storage andTransfer Program, and CO_2 fire suppression systems.

3. The following records will be maintained by the SOC Environmental Services Manager for CAPP mandated PSI collection activities for a minimum of five years:

    - The date of the Plan/information review;
    - The name of the persons who participated in the review; and
    - The results of the review (the updated Plan, the PSI, or the revised PSI).

7. INFORMATION PERTAINING TO CHEMICAL HAZARDS

Chemical Data: Mercury and Carbon Dioxide – [NAC 459.95412 (2)]
Chemical data for mercury and carbon dioxide are included in the manufacturer provided material safety data sheets (MSDS) in Attachment A: Bethlehem Apparatus Company, Mercury, 7439-97-6, 5/2/2000; Airgas, Carbon Dioxide, 124-38-9, 4/11/2005. The carbon dioxide (CO_2) Fire Suppression System PHA includes MSDSs for CO_2 (Chemetron), Methyl Alcohol (Sigma-Aldrich), and Methyl Salicylate 98% (Sigma-Aldrich).

8. TOXICITY INFORMATION: (NAC 459.95412 (2) (A) (1))

Mercury
Health Effects: Mercury is a neurotoxin that crosses the blood-brain barrier. The most severe, adverse health effects have been associated with chronic (long-term) exposure to mercury vapor. Mercury is highly toxic, irritating to skin, eyes, and other contaminated tissues, and causes sensitization and neurological symptoms. When inhaled, mercury is rapidly distributed throughout the body and accumulates in the brain, kidneys, and lungs.

Routes of Exposure: Inhalation, dermal contact and absorption, ingestion, and injection (i.e. through abrasions and lacerations of the skin).

Target Organs: Acute – respiratory system, integumentary system (skin and eyes), central nervous system (brain); Chronic – central nervous system, renal system (kidneys), integumentary system (skin and eyes), respiratory system, cardiovascular system (blood), reproductive system, gastrointestinal system, and hepatic system (liver).

Acute Toxicity: Short-term over exposures to high concentrations of mercury vapor can lead to breathing difficulty, coughing, and potentially fatal lung disorders. Mercury can be irritating to contaminated skin and eyes.

Chronic Toxicity: Long-term over exposures to mercury vapor can result in cardiac abnormalities, anemia, gastrointestinal abnormalities (abdominal pain, diarrhea, digestive problems, anorexia), renal abnormalities (frequent urination), peripheral neuropathy (numbness, weakness, burning sensations in the hands or feet, and tremors), central nervous system abnormalities (alteration of tendon reflexes, slurred speech, visual and hearing disturbances), and allergic reactions, i.e. breathing difficulty. Toxicological data have been collected on accidental exposures to humans and in clinical trials on rat and rabbit species.

Genotoxicity: Human mutation data were obtained during clinical studies on specific tissues exposed to high doses of mercury, suggesting that mercury is genotoxic.

Reproductive Toxicity: Mercury is a reproductive toxin in humans and other species. Impotence has been reported in over exposed males. Women occupationally exposed have reported menstrual disturbances, reduced ovulation, and spontaneous abortions. In animal studies, over exposures have resulted in spermatogenesis, including genetic material, sperm morphology, motility, and count (inhalation – male rat, 890 nanograms/cubic meters/24 hours). Mercury exposures (inhalation – female rat) have also resulted in embryo and fetus abnormalities and mortalities (embryotoxin).

Teratogenicity: Mercury has been reported to produce teratogenic effects in test animals, and it may cause teratogenic effects in humans.

Carbon Dioxide
Health Effects: Carbon dioxide is an asphyxiant, as it displaces oxygen. Exposure to high concentrations of CO_2 vapor can result in light headedness, dizziness, difficulty breathing, drowsiness, mental confusion, nausea, increased blood pressure, and increased respiratory rate. At higher concentrations, loss of consciousness, suffocation, and death have occurred. Individuals with existing disease would be at increased risk.

Direct contact with the cold gas or liquid can cause freezing of exposed tissues and associated pain, redness, burns, and corneal damage. Moisture in the air can react to form carbonic acid that causes eye and skin irritation.

Routes of Exposure: Dermal contact and inhalation

Target Organs: Respiratory system, skin, eyes, and cardiovascular system

Acute Toxicity: Lethal concentration (inhalation in humans) = 90,000 parts per million (ppm) for 5 minutes; carbon dioxide is a simple asphyxiant

Chronic Toxicity: Carbon dioxide has not been found to accumulate in tissues, resulting in long term adverse health effects

Genotoxicity: Carbon dioxide has not been found to cause mutagenic effects

Reproductive Toxicity: Carbon dioxide has not been found to cause adverse reproductive or developmental effects

9. PERMISSIBLE EXPOSURE LIMITS: [NAC 459.95412 (2) (A) (2)]

Permissible exposure limits (PEL) are airborne concentrations of a substance that represent the conditions under which it is generally accepted that nearly all workers may be repeatedly exposed without adverse effect. The duration must be considered, including the 8-hour time weighted average (TWA), the 15-minute short term exposure limit (STEL), and the instantaneous ceiling level. Skin absorption effects must also be considered.

Mercury
Occupational Safety and Health Administration (OSHA) PEL for mercury in air are the following:

- Mercury vapor TWA = 0.5 milligrams per cubic meters (mg/m^3) for skin exposure (1993)
- Mercury vapor STEL = 0.1 mg/m^3 for skin exposure (1993)
- Mercury vapor Ceiling = 0.1 mg/m^3 for skin exposure (1993)

The American Conference of Governmental Industrial Hygienists (ACGIH) has established the following Threshold Limit Values (TLV) for mercury in air:

- Mercury vapor TWA = 0.025 mg/m^3 for skin exposure
- Mercury vapor STEL = Not established
- Cancer Classification = A4 - Not Classifiable as a Human Carcinogen

Carbon Dioxide
OSHA PEL for carbon dioxide in air are the following:

- Carbon Dioxide TWA = 9,000 mg/m^3
- Carbon Dioxide STEL = 54,000 mg/m^3

The ACGIH has established the following TLVs for carbon dioxide in air:

- Carbon Dioxide TWA = 9,000 mg/m^3
- Carbon Dioxide STEL = 54,000 mg/m^3

10. PHYSICAL DATA: [NAC 459.95412 (2) (A) (3)]

Mercury
Mercury is a silver-white, heavy liquid that is odorless. Mercury is not flammable, and the evaporation rate is not determined.

Physical Form: Heavy liquid, vaporizes to the gaseous state
Relative Vapor Density (air = 1): 6.9
Vapor Pressure, mm Hg at 25 degrees C: 0.002
Specific Gravity (water = 1): 13.5939
Solubility in Water: Insoluble
Freezing Point: -38.87 degrees C (-37.97 degrees F)
Boiling Point: 356.72 degrees C (674.1 degrees F)
Odor: Odorless
Appearance: Mercury is a silver-white, heavy liquid

Carbon Dioxide
Carbon dioxide used in the fire suppression system at HWAD is a colorless, liquefied gas under pressure that is odorless to slightly acidic. Carbon dioxide is not flammable, and the evaporation rate is not applicable.

Physical Form: Liquified gas under pressure
Relative Vapor Density (air = 1): Heavier than air
Vapor Pressure, pound-force per square inch gauge (psig) at 25 degrees C and 1 atmosphere: 838
Specific Gravity (water = 1): 1.522
Solubility in Water: Soluble
Freezing Point: Not applicable
Boiling Point: -109.3 degrees F
Odor: Odorless to slightly acidic
Appearance: Carbon dioxide is a colorless, liquefied gas under pressure.

11. REACTIVITY DATA: [NAC 459.95412 (2) (A) (4)]

Mercury
Stability: Stable
Decomposition Products: Toxic concentrations of mercury vapor and mercury oxides can be generated if mercury is exposed to extremely high temperatures in the presence of oxygen.
Hazardous Polymerization: Will not occur
Conditions to Avoid: Avoid contact or exposure to extreme temperatures and incompatible chemicals.
Incompatible Materials to Avoid: Acetylene and acetylene derivatives, amines (i.e. ammonia), 3-bromopropyne, boron diiodophosphide, methyl azide, sodium carbide, heated sulfuric acid, methylsilane/oxygen mixtures, nitric acid/alcohol mixtures, tetracarbonylnickel/oxygen mixtures, alkyne/silver perchlorate mixtures, halogens (i.e. chlorine, bromine), and strong oxidizers (i.e. chlorine dioxide, perchlorates). Mercury can react strongly with copper and copper alloys. Mercury can react/combine with other metals to form amalgams (i.e. lithium, aluminum and rubidium).

Carbon Dioxide
Stability: Stable under normal conditions

Decomposition Products: In contact with moisture, CO_2 will form carbonic acid
Hazardous Polymerization: Will not occur
Conditions to Avoid: Heat, high temperatures, exposure to direct sunlight
Incompatible Materials to Avoid: Alkali or alkaline earth metals (i.e. aluminum, zinc) and strong oxidizing agents

12. CORROSIVITY DATA: [NAC 459.95412 (2) (A) (5)]

Mercury
Mercury is a corrosive material. U. S. Department of Transportation regulations define mercury as a Hazard Class 8 Corrosive Material [49 Code of Federal Regulations (CFR) 172.101]. As such, mercury is in Packing Group III for surface modes of transportation.

Carbon Dioxide
Carbon dioxide in contact with moisture will form carbonic acid that is corrosive. Strong oxidizing agents and alkali or alkaline earth metals combined with carbon dioxide also have corrosive properties.

13. THERMAN AND CHEMICAL STABILITY DATA: [NAC 459.95412 (2) (A) (6)]

Mercury
Stability: Stable
Decomposition Products: Toxic concentrations of mercury vapor and mercury oxides can be generated if mercury is exposed to extremely high temperatures in the presence of oxygen or air.
Hazardous Polymerization: Will not occur
Conditions to Avoid: Avoid contact or exposure to extreme temperatures and incompatible chemicals.

Incompatible Materials to Avoid: Acetylene and acetylene derivatives, amines (i.e. ammonia), 3-bromopropyne, boron diiodophosphide, methyl azide, sodium carbide, heated sulfuric acid, methylsilane/oxygen mixtures, nitric acid/alcohol mixtures, tetracarbonylnickel/oxygen mixtures, alkyne/silver perchlorate mixtures, halogens (i.e. chlorine, bromine), and strong oxidizers (i.e. chlorine dioxide, perchlorates). Mercury can react strongly with copper and copper alloys. Mercury can react/combine with other metals to form amalgams (i.e. lithium, aluminum, and rubidium).

Fire and Explosion: Mercury is not flammable and is relatively stable. Compatible fire extinguishing materials include water, foam, halon, carbon dioxide, dry chemical, and any "ABC" Class materials. Mercury vapors and mercury oxides generated during fires are toxic, and mercury can be irritating to contaminated tissues.

Carbon Dioxide
Stability: Stable under normal conditions
Decomposition Products: In contact with moisture, CO_2 will form carbonic acid
Hazardous Polymerization: Will not occur
Conditions to Avoid: Heat, high temperatures, exposure to direct sunlight

Incompatible Materials to Avoid: Alkali or alkaline earth metals (i.e. aluminum, zinc) and strong oxidizing agents

Fire and Explosion: Carbon dioxide is a non flammable gas that is used as a fire extinguishing agent. Containers and surrounding areas must be kept cool with water spray, as containers may rupture or burst in the heat of a fire.

14. FORSEEABLE HAZARDOUS EFFECTS OF INADVERTENT MIXING OF DIFFERENT MATERIALS: [NAC 459.95412 (2) (a) (7)]

Mercury
Decomposition Products: Toxic concentrations of mercury vapor and mercury oxides can be generated if mercury is exposed to extremely high temperatures in the presence of oxygen or air.

Conditions to Avoid: Avoid contact or exposure to extreme temperatures and incompatible chemicals.

Incompatible Materials to Avoid: Acetylene and acetylene derivatives, amines (i.e. ammonia), 3-bromopropyne, boron diiodophosphide, methyl azide, sodium carbide, heated sulfuric acid, methylsilane/oxygen mixtures, nitric acid/alcohol mixtures, tetracarbonylnickel/oxygen mixtures, alkyne/silver perchlorate mixtures, halogens (i.e. chlorine, bromine), and strong oxidizers (i.e. chlorine dioxide, perchlorates). Mercury can react strongly with copper and copper alloys. Mercury can react/combine with other metals to form amalgams (i.e. lithium, aluminum, and rubidium).

Carbon Dioxide
Decomposition Products: In contact with moisture, CO_2 will form carbonic acid

Conditions to Avoid: Heat, high temperatures, exposure to direct sunlight

Incompatible Materials to Avoid: Alkali or alkaline earth metals (i.e. aluminum, zinc) and strong oxidizing agents.

15. INFORMATION PERTAINING TO PROCESS TECHNOLOGY

Block Flow Diagram: [NAC 459.95412 (2) (b) (1)]
The process hazard analysis (PHA) team developed comprehensive flow charts for the application of the What-If Methodology. Likewise, the PHA team developed a process flow diagram for the CO_2 Fire Suppression System for the application of the Hazardous Operability Study Methodology (Attachment B).

Process Chemistry: [NAC 459.95412 (2) (b) (2)]
NAC 459.95412 (2) (b) (2) is not applicable to the Hg storage or CO_2 systems, because neither process involves chemical reactions. Methyl alcohol and methyl salicylate are added to the CO_2 as an odorant prior to its discharge, but neither odorants are reactants nor do they induce a chemical reaction.

16. MAXIMUM INTENDED INVENTOR: [NAC 459.95412 (2) (b) (3)]

Mercury
The maximum intended onsite inventory of mercury is approximately 4,890 tons that will be stored in 14 buildings.

Carbon Dioxide
The maximum intended onsite inventory of CO_2 in the fire suppression system is 14 six-ton CO_2 tanks. The tank capacity with a 10% safety factor is 10,800 pounds, and total onsite inventory is 151,200 pounds.

17. SAFE UPPER AND LOWER LIMITS: PRESSURE AND TEMPERATURE [NAC 459.5412 (2) (b) (4)]

Mercury Flasks

The flasks in the DLA Strategic Materials mercury stockpile typically hold 2.5 liters (L) (0.66 gal), or 34.5 kg (76 lb) of mercury. The flasks are constructed primarily of low carbon steel and have a nominal internal volume of 3 L (0.79 gal). The flasks vary somewhat in size, shape, and construction details, but all are right circular cylinders with a threaded plug at the flask port on the top. The flasks are approximately 21–44 centimeters (cm) (8.3–17.3 inches) tall (excluding the flask port and plug) and 10–14 cm (3.9–5.5 inches) in diameter. The flasks were procured at various times and from various sources over an extended period.

Based on dimensional measurements performed by the Oak Ridge National Laboratory (ORNL) during a flask characterization study (ORNL/TM-2009/003), the tallest flask types had an average shell height of 440.1 millimeters (mm). Although there is void space in the flasks that allows for volume expansion due to temperature change, the shell height represents the conservative point to determine the maximum static pressure due to the liquid contents. Calculations for the tallest flask in the ORNL study indicate that the maximum static pressure in the flasks is 8.6 pounds force per square inch (lb_f/in^2).

In the ORNL flask characterization study, hydrostatic testing was performed on a select number of the DLA Strategic Materials inventory of mercury flasks and included various flask types. The lowest pressure at which a flask failure occurred was 760 lb_f/in^2; however, some flasks did not fail even when the pressure was increased to approximately 2500 lb_f/in^2. For comparison, ORNL also performed hydrostatic pressure testing on a newly manufactured flask by a commercial entity. This flask failed at a pressure of 700 lb_f/in^2. A comparison of the hydrostatic pressure failure data with the maximum static pressure indicates that there the flasks held pressure at least 80 times that required for the maximum static pressure; therefore, the flasks are more than adequate for storing mercury in ambient atmospheric conditions, which is the plan for the DLA Strategic Materials inventory of mercury flasks.

Seasonal temperatures (average, minimum, and maximum) in the vicinity of Hawthorne are presented in Attachment C. Based on the highest average temperature, July, which had an average high of 96.3°F, is the warmest month.

Mercury Drums

The drums in which the flasks of mercury are stored were procured from Skolnik Industries. The drums are 30-gallon, open—head, and fabricated of carbon steel. They have United Nations (UN) markings of 1A2/X235/S &-IA2/YJ.5/200. The inside diameter is approximately 18.25 inches and the height is approximately 26 inches. The drum lid is fitted with an ethylene propylene diene monomer in-cover "D" gasket.

Commercial drums for hazardous materials containment are constructed to meet or exceed the UN performance packaging standards specified in 49 CFR, sections 178.600 through 178.608, for the packing group level specified. The 30-gallon drums used for storing six flasks are performance packages in the Packing Group I level, two levels higher than the required Packing Group III.

A performance packaging must be subjected to drop testing, leak proof testing, hydrostatic pressure testing, and vibration testing. Until packaging has successfully undergone these tests, it cannot be certified as a UN performance packaging. The manufacturer's certificate indicates that the packaging (30-gallon steel drums used by DLA Strategic Materials) has successfully met or exceeded the UN performance standards for Packaging Groups I and II for solids, and Packaging Group II for liquids. Since the mercury primary containers are the flasks, the drum is considered to be containing solids. In the event that mercury should leak into the drum, the drum would become the primary container and its certification for containing liquids exceeds the requirement of Packaging Group III (the

packaging group specified for elemental mercury in 49 CFR 172.101 Hazardous Materials Table). The test report for the 30-gal drums is in Attachment D.

Carbon Dioxide
The CO_2 fire suppression storage tank has an automatic bleeder valve set at 341 pounds per square inch (psi) and an automatic tank safety valve set at 357 psi. The pressure vessel maximum allowable working pressure is 357 psi at 200°F, as specified on the nameplate of the vessel.

Carbon Dioxide Odorant
The CO_2 gas in the fire suppression systems is odorized, similar to natural gas. If there is a leak in the distribution system piping, discharge points or valves, the CO_2 gas can be smelled – indicating that there is a leak in the system. The MSDSs for Methyl Alcohol (Sigma-Aldrich) and Methyl Salicylate 98% (Sigma-Aldrich), included in the CO_2 system PHA, are for the ingredients used to odorize the CO_2 gas. The methyl salicylate provides a recognizable wintergreen odor. No stream composition limits are involved.

18. EVALUATION OF THE CONSEQUENCES OF DEVIATIONS: PRESSURE AND TEMPERATURE [NAC 459.5412 (2) (B) (4)]

The consequences of deviations were evaluated thoroughly during the PHA for the receipt and storage of mercury and the CO_2 fire suppression systems. As the mercury PHA concluded, the storage process is unlike a conventional chemical manufacturing process. It has no process chemistry involving process reactions that might occur during static storage under normal operating conditions or abnormal operating conditions. Only an external event, such as a fire, might affect pressures within the 30-gallon drums or the flasks contained in these drums. This situation is not considered a deviation in the operation of a process. It is considered a catastrophic event beyond any normal operating conditions.

The consequences for a catastrophic event include popping open of the drum lids if pressures inside the drums due to a fire (an elevated temperature event) increase beyond the test pressures of 36 psig. The flasks have shown failure pressures ranging from 850 psi to 1320 psi. Before such a deviation could occur in the normal ambient static storage process caused by an elevated temperature event, the CO_2 fire suppression system would discharge CO_2 and minimize the consequences arising from the abnormal condition in the storage process.

19. INFORMATION RELATED TO THE PROCESS EQUIPMENT

Equipment, instrumentation and materials used in the Mercury Storage and Transfer Program process have been evaluated for compatibility, design parameters, instrument design, and control logic. The equipment used to store and transfer mercury and CO_2 has been designed to eliminate incompatibility issues, meet ambient temperature and pressures, and/or meet manufacturer's design specifications.

See attached PSI addendum for the process equipment Mobile Mercury Transfer Station.

Materials of Construction: [NAC 459.95412 (2) (c) (1)]
The mercury storage warehouses are constructed of concrete reinforced with rebar – floors, walls, and columns; steel roof trusses, transite ceiling and roofing; and ceiling air vents. Warehouse dimensions are 50 feet by 200 feet.

The flasks in the DLA Strategic Materials mercury stockpile typically hold 2.5 L (0.66 gal), or 34.5 kg (76 lb) of mercury. The flasks are constructed of carbon steel and have an internal volume of roughly 3 L (0.79 gal). The flasks vary somewhat in size, shape, and construction details, but all are right circular cylinders with a threaded plug at the flask port on the top. The flasks are approximately 21–44 cm (8.3–17.3 inches) tall (excluding the flask port and plug) and 10–14 cm (3.9–5.5 inches) in diameter. The flasks were procured at various times and from various sources over an extended period.

The storage drums are constructed of carbon steel.

Flask structural integrity – Oak Ridge National Laboratory staff members have reported the results from their studies of the flasks and drums in which the DLA Strategic Materials mercury stockpile is stored. These research findings (eight detailed technical memoranda and 22 white papers) were submitted to NDEP. The research findings lead directly to the statement given in ORNL/TM-2009/010 (*Executive Summary Report*): "With structured monitoring and inspections, the existing storage configuration is suitable for safe storage throughout the 40 year storage life."
Six (6) flasks are placed in a 30-gallon epoxy-lined drum, encased with a polyethylene liner, and are individually separated by cardboard dividers. Five (5) drums are placed in a metal drip tray on a wooden pallet. The pallets are to be set in a single layer on the warehouse floor. The floors are sealed with TERANAP (TER-431), a chemical resistant coating, to prevent mercury migration into the concrete floor. The floors have berms and curbing to prevent mercury spills from migrating out of the building.

ORNL conducted a drum characterization study (ORNL/TM-2009/002). The study contains information concerning the drums, drum seals, bottom pad, polyethylene liner, cardboard dividers, and 10-inch square pillow.

The mercury storage flasks, constructed of carbon steel, and steel drums are compatible with the stored elemental mercury. Mercury does not wet steel at temperatures below 400°C and iron oxide(s) are stable on the surface of the flasks and drums in the presence of air. Thus, chemical interactions between the flasks or drums and mercury are extremely unlikely at temperatures anticipated to be encountered during warehouse storage.

U-1A Form (CO_2 PHA Appendix 7) is provided for the CO_2 Fire Suppression Storage Tank and addresses CO_2 service. As described in detail in the PHA, the CO_2 Fire Suppression System was supplied as a package including piping and components.

Flame, smoke, and heat detectors are installed in each of the 14 mercury storage warehouses. The flame detectors are Spectrex, Inc. Mini Triple IR (IR3). Fixed temperature heat detectors are set at 190°F. Smoke detectors are described in the Mercury Storage Program Safety System Description (Attachment E).

Instruments associated with the mercury storage process are Lumex and Jerome Mercury Vapor Analyzers for ambient monitoring. Instruments associated with the CO_2 fire suppression system are supplied as part of the package provided by the vendors Chemetron and Tri-Signal, Inc.

Piping and Instrumentation Diagrams (P&IDs): [NAC 459.95412 (2) (c) (2)]
As-built drawings with P&ID Information for the CO_2 fire suppression systems are on file in SOC Engineering Services (Attachment F); these drawings incorporate detectors and alarms. P&ID and control logic accuracy were confirmed by SOC Engineering Services and the PHA team for the CO_2 system. Smoke, flame, and heat detectors and motion detectors are covered in the Safety System Description (Attachment E).

Electrical Classification: [NAC 459.95412 (2) (c) (3)]
NAC 459.95412 (2)(c)(3) is not applicable to the Hg storage or CO_2 systems, because neither process involves electrically hazardous areas, defined pursuant to Article 500 of the National Electric Code.

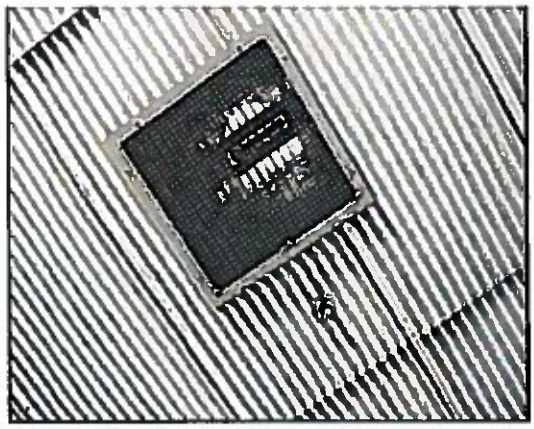
Design of the Relief System and Basis for the Design: [NAC 459.95412 (2) (c) (4)]
The CO_2 fire suppression system contains an Anderson Greenwood pressure relief valve (PRV) system set at 341 psi and 357 psi, respectively, for bleeder and pressure relief. The PRV Anderson Greenwood valve model is 63BM68.7. The pressure vessel (CO_2 tank) maximum allowable working pressure 357 psi and 200°F per the name plate. The tank was hydro tested at 540 psi. The CO_2 tank capacity is 12,000 lbs and the maximum volume (basis is mass of CO_2) allowed through administrative control is 10,800 lbs. Pressure relief devices, settings, and capacities were tested by the system vendor at the time of its commission. The Chemetron Fire System, Safety Relief Valve Data, Sizing Calculations for 4, 6 8, and 10 Ton Liquid CO_2 Storage Assemblies (document # CALC-LP-0001 – 12/11/1981) and all system were determined to be sufficient. The results of these tests were reviewed during the PHA and are included in the PHA report or the CO_2 system.

NOTE: The Anderson Greenwood valve model number 63BM68-7 is the actual valve installed on the CO_2 tanks at HWAD. This model number corresponds to the Chemetron relief valve 1-061-0753 on the as-built drawings for CO_2 tank installation at HWAD. The Chemetron number is the re-ordering number for the Anderson Greenwood relief valve.

Design of the Ventilation System: [NAC 459.95412 (2) (c) (5)]
In accordance with NAC 459.95412 (2) (c) (5) and NAC 459.95412(3), a description is provided of the ventilation system servicing the mercury storage warehouse.

Each warehouse has six (6) roof vents along the ridge of the roof. The second and fifth vents are each connected to a 0.9 m × 0.9 m (3 ft by 3 ft) register in the ceiling directly below it by a duct. These vents are equipped with dampers in the circular duct near the exhaust. The dampers are controlled by a rope that passes through a fixture in the ceiling adjacent to the register. The four other 0.9 m × 0.9 m (3 ft by 3 ft) ceiling registers are located in the ceiling, about 0.9 m (3 ft) from the east wall. These vents open to the space between the ceiling and the roof.

Ventilation Description for Mercury Storage Warehouses at HWAD
Each warehouse has six (6) roof vents along the ridge of the roof. The second and fifth vents are each connected to a 0.9 m × 0.9 m (3 ft by 3 ft) register in the ceiling directly below it by a duct. These vents are equipped with dampers in the circular duct near the exhaust. The dampers are controlled by a rope that passes through a fixture in the ceiling adjacent to the register. The four other 0.9 m × 0.9 m (3 ft by 3 ft) ceiling registers are located in the ceiling, about 0.9 m (3 ft) from the east wall. These vents open to the space between the ceiling and the roof.



Example of ceiling register vent

Ventilation exhaust ducts in the warehouse roofline.

Assumptions:

- Wind-driven natural ventilation
- Common air chemistry, at standard temperature and pressure for baseline conditions. (Hg vapor lift was not considered)
- Low structural permeability to air flow
- Max of two outermost (approximately 8.3 ft wide by 8.7 ft high) doors open during occupancy
- Simple 3 ft diameter galvanized steel ductwork, immediately after 3 ft × 3 ft square ceiling grill
- No air turbine in ventilator nor obstructive debris in ductwork

Prints were scaled to get a 'target' flow rate of approximately 417 × 10^3 ft^3/hr for two volume changes of the full warehouse, including attic volume. The conceptual HWAD warehouse ventilation path was modeled with eight (8) resistive elements from ceiling grill to ventilator. These elements were assigned resistive coefficients per Mark T3.3.10/3.3.11. Given the short length of large 3 ft duct, low duct resistance (K-eq approximately 3 to 4) and turbulence (Reynolds number greater than 4,000) were calculated, even for low wind speeds [less than 0.25 (1/4) miles per hour].

For wind driven ventilation, venturi negative is assumed from air passing under the roof ventilator lips, while the exposed streamline entering the door was assumed near-stall, affecting positive pressure. For six (6) exhaust ducts, Colebrook iteration (f approximately 0.01344) resulted in a low pressure differential (0.02885 lb/ft^2), with orthogonal wind speed of approximately 2.4 miles per hour sufficient to give the target flow rate. If venturi negative at roof ventilator lips is not included in the model, then approximately 3.4 miles per hour is sufficient to 'push only' up through the six (6) ducts at the target flow. Both of these values are under the climatic average for Hawthorne, so (if the wind direction is right) then target flow appears feasible.

Since the average HWAD wind speed is over five (5) mph throughout the year, and since six 6 ft diameter ducted roof exhausts are of low resistance, a low (2.4 to 3.4 miles per hour) perpendicular component of air velocity on two open doors should be sufficient to give two (2) volume changes per hour.

HWAD Standard Operating Procedures
SOC operates the Hawthorne Army Depot. In managing the storage of mercury at the Depot, SOC has developed procedure "Mercury Monitoring & Response" (DPD.IOP.FES.0019) which requires the breathing zone air to be checked for mercury vapor concentration prior to allowing personnel to enter the building to work (e.g., inspect the inventory). SOC has also prepared a standard operating procedure for receiving and storing the mercury inventory in the warehouses. The procedure "Elemental Mercury: Receipt and Storage" (DZHC-0000-M-010) specifies that the storage personnel will not enter the building until the mercury vapor concentration has been determined to be within established guidelines. After the mercury inventory has been placed in the warehouses, DLA Strategic Materials will perform quarterly, routine inspections of the inventory. These inspections will be performed under standard operating procedure named "Mercury Storage Site & Stockpile Inspection" (SOC.QP.QAD.0002). The site uses the recommendation of the American Conference of Governmental Industrial Hygienists (ACGIH) as the safe concentration of mercury vapor in air, which is 25,000 ng/m^3 on a time weighted average.

Overview of Warehouse Ventilation System
Prior to entry two (2) sets of mercury concentration measurements at floor and breathing levels are taken to verify health and safety requirements for safe entry. To add rigor to understanding the physical system, but not required, the calculation basis and results presented above show the conditions needed to achieve two building air changes per hour, which is typical for occupied homes. The results of the calculations demonstrate that the fresh air requirements, 0.06 ft^3/minute per ft^2 of warehouse space (Table 6.1 of ASHRAE 62.1-2007) are satisfied when two (2) doors are open. References are given to HWAD operating procedures which require that work within the warehouses be performed with four (4) doors open.

Design Codes and Standards Employed: [NAC 459.95412 (2) (c) (6)]
There are no design codes, specifications, or engineering practices related to the static storage of mercury. The CO_2 fire suppression system manufacturer (Chemetron) references National Fire Protection Association (NFPA) and American Society of Mechanical Engineers (ASME) for the CO_2 storage tank.

Material and Energy Balances: [NAC 45995412 (2) (c) (7)]
NAC 459.95412 (2) (c) (7) is not applicable to the Hg storage or CO_2 systems.

Safety Systems, Such as Interlocks, Detection or Suppression Systems: [NAC 459.95412 (2) (c) (8)]
The safety systems include the interlocks and emergency shut-off systems in the CO_2 fire suppression systems that are covered in detail in the PHA report. Flame, smoke, and heat detectors, fire extinguishers, SOC FES, and the CO_2 fire suppression systems provide multiple redundancies for the protection of mercury in the storage warehouses. A Safety System Description has been written (Attachment E) to include the applicable systems in place for the Mercury Storage and Transfer Program.

20. MANAGEMENT PLAN AND DOCUMENT CONTROL

Control of Documents will be in accordance with Mercury Management Plan.

For purchases and installation of equipment or modifications to facilities SOC utilizes the SOC Purchasing Manual, QP.SOC.0011 which is contained as a Tier 3 Document in the Mercury library at the HWAD. This is a comprehensive document covering all aspects to ensure review of specification, drawing submittals, acceptance testing, onsite inspections, remedial actions, and dispute resolutions.

Corps of Engineers projects that are performed at HWAD associated with the Mercury Storage Program are managed in accordance with stringent procurement regulations and specifications generated by the Army.

21. EVALUATION OF CODE APPLICABILITY AND COMPLIANCE

There are no applicable codes, standards, or engineering practices related to the static storage and transfer of mercury. Chemetron, the CO_2 fire suppression system manufacturer, references NFPA and ASME for the CO_2 storage tank. The flame, smoke, and heat detectors and fire extinguishers meet NFPA codes and standards.

22. CODES, STANDARDS, OR PRACTICES NO LONGER IN GENERAL USE

NAC 459.95412 (4) is not applicable to the Hg storage or CO_2 systems.

23. REFERENCE

- NDEP/CAPP Process Safety Information Element Audit Checklist
- Chemetron Fire System Safety Relief Valve Data Sizing Calculation for 4, 6, 8 and 10 Ton Liquid CO_2 Storage Assemblies (document # CALC-LP-0001 – 12/11/1981)
- U-1A Form: Manufacturer's Data Report for Pressure Vessels (see CO_2 PHA Appendix 7)
- MSSP-03, Interpreting Mercury Concentrations in Drum Head Spaces
- ORNL/TM-2009/002, Drum Characterization for the DLA Strategic Materials Mercury Stockpile
- ORNL/TM-2009/003, Flask Characterization for the DLA Strategic Materials Mercury Stockpile (2 volumes)
- ORNL/TM-2009/010, Executive Summary Report
- ASHRAE 62.1, Ventilation for Acceptable Indoor Air Quality
- Management of Change Standard Procedure
- ISO 14001 Internal Audit Standard Procedure
- Standard Operating Procedure Program
- CAPP Compliance Audit Program
- Process Hazard Analysis Procedure
- DPD.IOP.FES.0019, Mercury Monitoring and Response
- SOC.QP.QAD.0002, Mercury Storage Site & Stockpile Inspection
- QP.SOC.0011, SOC Purchasing Manual

24. ATTACHMENTS

Attachment A: Material safety data sheets: Defense Logistics Agency, Mercury, 7439-97-6, 12/7/2006; Carbon Dioxide (Fire Extinguishing Agent and Expellant) (Chemetron Fire Systems); Methyl Alcohol (Sigma-Aldrich); and Methyl Salicylate 98% (Sigma-Aldrich)

Attachment B: Process flow diagram for the CO_2 Fire Suppression System for the application of the HAZOP Methodology

Attachment C: Seasonal Temperatures at Hawthorne, Nevada

Attachment D: Drum Test Report

Attachment E: Safety System Description - A Description of the Mercury Storage Program Safety Systems & Functions & Mercury Transfer Safety System and Function

Attachment F: As Built Drawings / P&IDs

PSI Addendum: PSI for Mobile Mercury System Transfer 2014-MSSP-41, Rev. 1

25. FORMS

10.1 The following forms are applicable to this document

APPLICABLE FORMS	
FORM NUMBER	TITLE